



Joint Rapid Airfield Construction

Mechanical Behavior of Freezing/Thawing Airfield Structures

CRREL

<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>
\$200K	\$200K	\$200K	\$100k

Project Description

Objective:

- **To Simulate** mechanical behavior of freeze/thaw layering for potential and expedient airfield structures.
- **Integrate** design parameters specific to freezing/thawing structure into deterioration performance for JRAC software.

Approach:

- **Generate** high-fidelity engineering models for freezing/thawing airfield structures and **validate** models using field and laboratory data
- **Obtain freeze/thaw** predictions and material properties based on Remote Condition Assessment and Materials Property database work units and use these to bound performance
- **Develop performance measures and incorporate** into JRAC performance/deterioration algorithms.

Plan:

FY03 -

- ✓ Document mechanical behavior analysis for thawing Lebanon Sand
- ✓ Develop constitutive equations for A4 material (HPC project with USMA)
- ✓ Assemble well characterized data sets of airfield/pavement structures including thawing conditions for material model and design software validation

FY04 -

- Validate material models
- Develop software modifications to evaluate a variety of thawing and layering conditions
- Analyze multi-pass data from FERF to generate deterioration equations

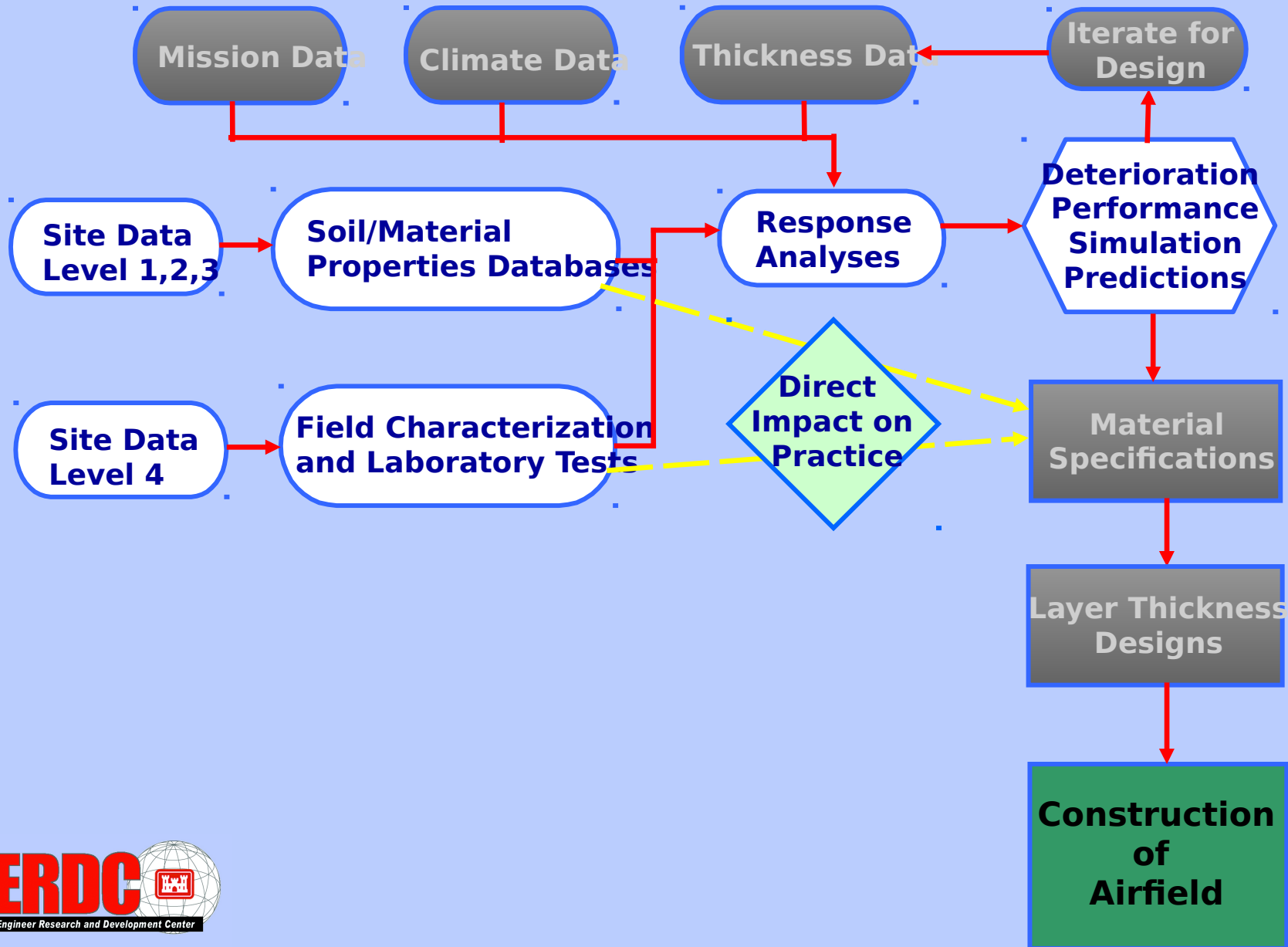
FY05 -

- Model predictions of strain and rutting for a variety of freezing/thawing conditions

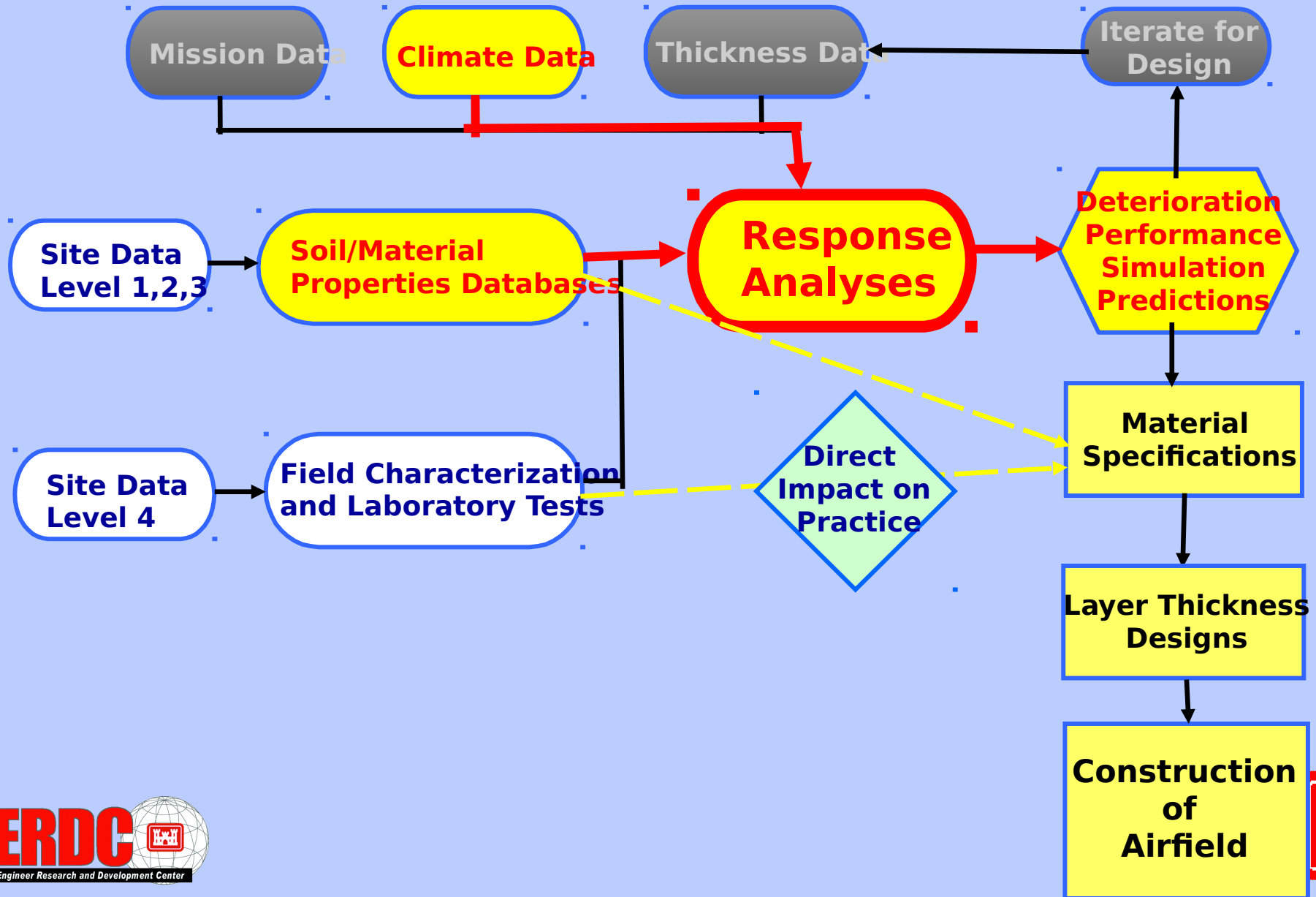
FY06 -

- Incorporate guidelines into JRAC framework and verify

Performance Based Site Selection

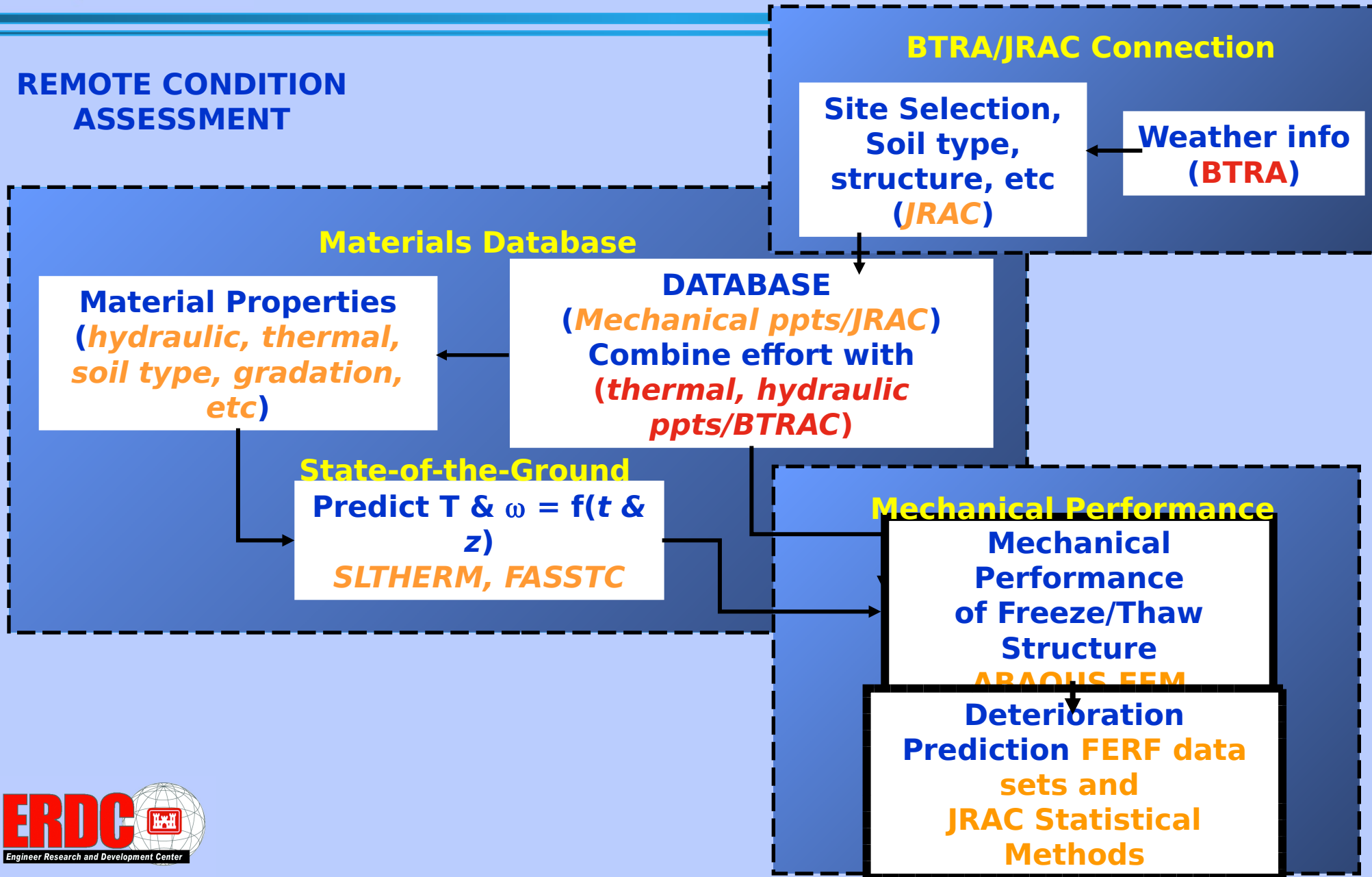


Performance Based Site Selection



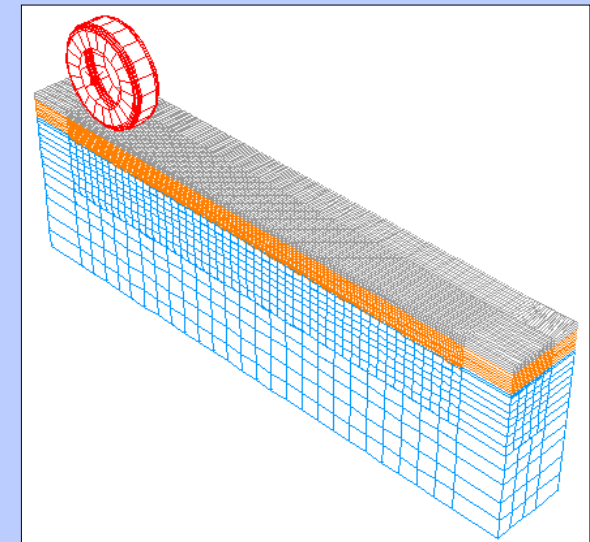
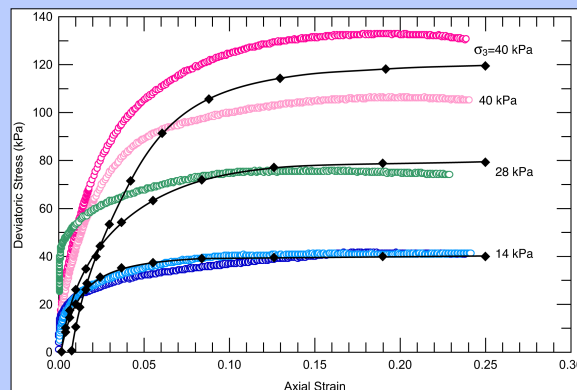
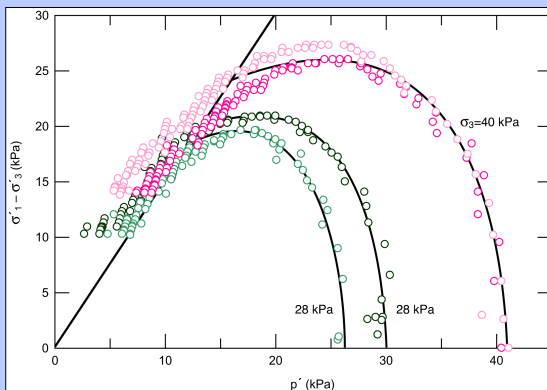
Seasonal Impacts on Site Selection (CRREL)

REMOTE CONDITION ASSESSMENT



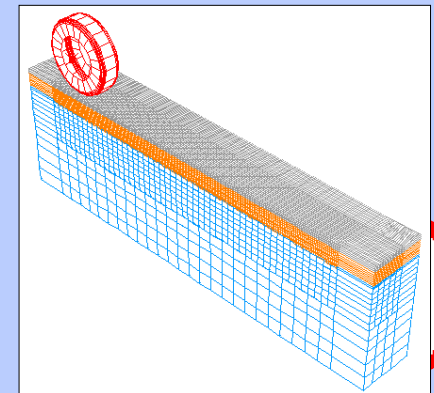
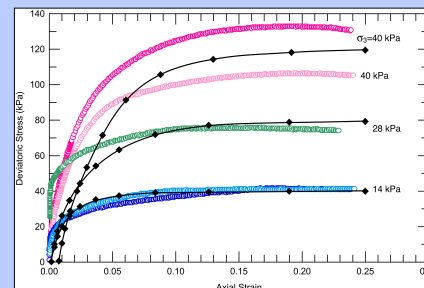
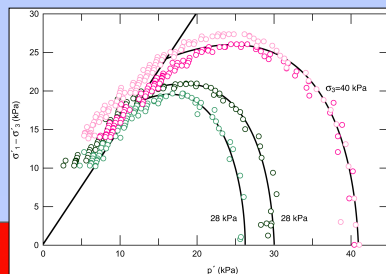
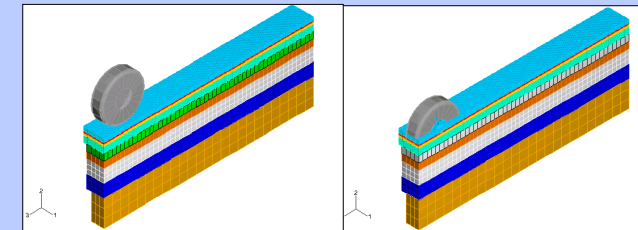
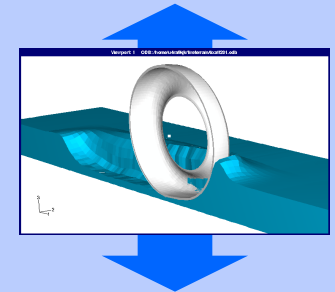
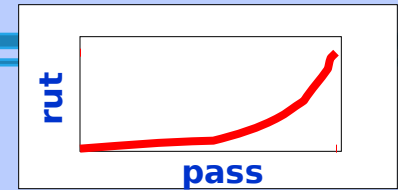
Accomplishments:

- **Developed Thawing Soils Material Model** for a frost susceptible sand (Lebanon Sand), validated with triaxial test data, implement in 3D dynamic simulation.
- **Documented** Thawing soils material model in Deformation Behavior of Geomaterials, France, Sept. 2003.
- **Scripted Multi-layer FEM**, for easily changing material properties and layering geometry
- **Develop A4 material model**, verify with triaxial data, implement in multi-layer 3D FEM (HPC project with USMA).



FY04/05:

- **Fine Tune layered model**
- **Verify/Validate Simulations** for layered model with Lebanon Sand, A4, pavement (or not), freeze/thaw layering
- **Parametric Study** of Freeze/Thaw layering
- **Define Target Aircraft** loading and geometric data (C130, C17)
- **Analyze multi-pass data** from FERF to generate deterioration equations



End Capabilities:

- **Mechanical behavior model for thawing soil for use in structural analysis**
- **Mechanical characterization of validation materials for material database**
- **Freeze/thaw structural performance guidelines**
- **Verified freeze/thaw guidelines in JRAC software**

Connectivity to other Work Units:

- Thawing soils test data to “Characterization and Behavior of Unbound Pavement Materials” (***JRAC/AT-40***)
- Soil properties data to/from “Material Property Prediction/Database” (***AJRAC/DT-08***)
- Use Freeze/thaw predictions from “Remote Condition Assessment” (***JRAC/DT-08***)
- Performance input to “Deterioration Predictions for Un-surfaced Airfields” (***JRAC/CT-08***)